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Docket No. ALG08NP

Mail Label No. EF103846778US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Vahala et al
Filed: 02/16/2001
App. No.: 09/788,300
For: Resonant optical filters

PRELIMINARY AMENDMENT UNDER 37 CFR §1.115

Assistant Commissioner for Patents
Washington, DC 20231

07/30/2001

Sir:

Please amend the above named application as set forth below.

AMENDMENT

Please insert the following new claims.

15. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the second transmission optical waveguide having an evanescent optical coupling segment; and
- a plurality of optical resonators forming a coupled-optical-resonator system and including at least one fiber-ring optical resonator, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring

optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes.

16. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a plurality of optical resonators forming a coupled-optical-resonator system and including at least one fiber-ring optical resonator, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes.

17. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;

a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment; and

a plurality of axially evanescently optically coupled fiber-ring optical resonators formed on a common resonator optical fiber, the plurality of fiber-ring optical resonators forming a coupled-optical-resonator system, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of at least one immediately adjacent portion of the common resonator optical fiber so as to enable the plurality of fiber-ring optical resonators to support a plurality of substantially circumferential resonant optical modes near an outer circumferential surface of at least one of the fiber-ring optical resonators, the resonant optical signal being substantially resonant with at least one of the resonant optical modes.

18. A resonant optical filter, comprising:

a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;

a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment; and

a plurality of radially evanescently optically coupled fiber-ring optical resonators, each of the fiber-ring optical resonators being formed on a corresponding one of at least two

resonator optical fibers, the plurality of fiber-ring optical resonators forming a coupled-optical-resonator system, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with the corresponding resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of at least one immediately adjacent portion of the corresponding resonator optical fiber so as to enable the plurality of fiber-ring optical resonators to support a plurality of resonant optical modes near an outer circumferential surface of at least one of the fiber-ring optical resonators, the resonant optical signal being substantially resonant with at least one of the resonant optical modes.

19. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a plurality of optical resonators forming a coupled-optical-resonator system and including at least one fiber-ring optical resonator, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having

a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, a spectral width of at least one resonance band of the coupled-optical-resonator system being smaller than an optical channel spacing of the optical WDM system.

20. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a plurality of optical resonators forming a coupled-optical-resonator system and including at least one fiber-ring optical resonator, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, a spectral width of at least one resonance band of the

coupled-optical-resonator system being substantially equal to an optical channel spacing of the optical WDM system.

21. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a plurality of optical resonators forming a coupled-optical-resonator system and including at least one fiber-ring optical resonator, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, at least one spacing between spectrally-adjacent resonance bands of the coupled-optical-resonator system being greater than an optical channel spacing of the optical WDM system.

22. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide

optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;

a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;

and

a plurality of optical resonators forming a coupled-optical-resonator system and including at least one fiber-ring optical resonator, the coupled-optical-resonator system being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, spectrally-adjacent resonance bands of the coupled-optical-resonator system being spaced by about an integer times an optical channel spacing of the optical WDM system.

23. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the second transmission optical waveguide having an evanescent optical coupling segment; and
- a single fiber-ring optical resonator, the fiber-ring optical resonator being evanescently optically coupled to each of the first transmission optical waveguide and the second

transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes.

24. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a single fiber-ring optical resonator, the fiber-ring optical resonator being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring

optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes.

25. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a single fiber-ring optical resonator, the fiber-ring optical resonator being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, a spectral width of at least one resonance of the fiber-ring optical resonator being smaller than an optical channel spacing of the optical WDM system.

26. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide

optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
and
a single fiber-ring optical resonator, the fiber-ring optical resonator being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, a spectral width of at least one resonance of the fiber-ring optical resonator being substantially equal to an optical channel spacing of the optical WDM system.

27. A resonant optical filter, comprising:

a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
and

a single fiber-ring optical resonator, the fiber-ring optical resonator being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, at least one spacing between spectrally-adjacent resonances of the fiber-ring optical resonator being greater than an optical channel spacing of the optical WDM system.

28. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a single fiber-ring optical resonator, the fiber-ring optical resonator being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a

circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, spectrally-adjacent resonances of the fiber-ring optical resonator being spaced by about an integer times an optical channel spacing of the optical WDM system.

29. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the first transmission optical waveguide having an evanescent optical coupling segment;
 - a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the second transmission optical waveguide having an evanescent optical coupling segment; and
 - a resonant optical component, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide,
- at least one of the first transmission optical waveguide and the second transmission optical waveguide being a polarization-preserving optical fiber and the evanescent optical coupling segment thereof being a fiber-optic taper segment.

30. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the second transmission optical waveguide having an evanescent optical coupling segment; and

a resonant optical component, evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof, for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide,

at least one of the first transmission optical waveguide and the second transmission optical waveguide being an optical fiber and the evanescent optical coupling segment thereof being a side-etched optical fiber segment.

31. A resonant optical filter, comprising:

a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;

a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;

and

a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes, the resonator optical fiber including at least one delocalized-optical-mode suppressor.

32. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes,
- at least one of the first transmission optical waveguide and the second transmission optical waveguide being an optical fiber and the evanescent optical coupling segment thereof being a fiber-optic taper segment,
- the resonator optical fiber including a fiber-optic taper positioning-and-support structure for engaging the fiber-optic taper segment so as to evanescently optically couple the resonant optical component and the fiber-optic taper segment through a fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator.

33. A resonant optical filter, comprising:

a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;

a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;

and

a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes,

at least one of the first transmission optical waveguide and the second transmission optical waveguide being an optical fiber and the evanescent optical coupling segment thereof being a fiber-optic taper segment,

the resonator optical fiber including a fiber-optic taper positioning-and-support structure for engaging the fiber-optic taper segment so as to evanescently optically couple the resonant optical component and the fiber-optic taper segment through a fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator,

the fiber-optic-taper segment being engaged by the fiber-taper positioning-and-support structure at a location axially displaced from an axial midpoint of the fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator so as to

substantially reduce undesirable fiber-optic-taper-induced optical loss of the fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator.

34. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes,
- at least one of the first transmission optical waveguide and the second transmission optical waveguide being an optical fiber and the evanescent optical coupling segment thereof being a fiber-optic taper segment,
- the resonator optical fiber including a fiber-optic taper positioning-and-support structure for engaging the fiber-optic taper segment so as to evanescently optically couple the resonant optical component and the fiber-optic taper segment through a fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator,

the fiber-optic-taper segment being engaged by the fiber-taper positioning-and-support structure at a location radially displaced from an outer circumference of the fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator so as to substantially reduce undesirable fiber-optic-taper-induced optical loss of the fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator.

35. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- and
- a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes,
- at least one of the first transmission optical waveguide and the second transmission optical waveguide being an optical fiber and the evanescent optical coupling segment thereof being a fiber-optic taper segment,

the fiber-optic-taper segment being partially wrapped around a fiber-optic-taper-segment-coupled one of the at least one fiber-ring optical resonator near a portion of an outer circumference thereof.

36. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, the second transmission optical waveguide having an evanescent optical coupling segment;
- a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes; and
- a modulator switchable between first and second operational states for controlling transfer of the resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the modulator substantially enabling transfer of the resonant optical signal while in the first operational state and substantially preventing transfer of the resonant optical signal while in the second operational state.

37. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide

optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes; and
a modulator switchable between first and second operational states for controlling transfer of the resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, the modulator substantially enabling transfer of the resonant optical signal while in the first operational state and substantially preventing transfer of the resonant optical signal while in the second operational state.

38. A resonant optical filter, comprising:

a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide

optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment; a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes; and a modulator switchable between first and second operational states for controlling optical loss the resonant optical component, the modulator substantially enabling transfer of the resonant optical signal while in the first operational state and substantially preventing transfer of the resonant optical signal while in the second operational state.

39. A resonant optical filter, comprising:

a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment; a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment; a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal

between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes; and

a modulator switchable between first and second operational states for controlling evanescent optical coupling between the resonant optical component and at least one of the first transmission optical waveguide and the second transmission optical waveguide, the modulator substantially enabling transfer of the resonant optical signal while in the first operational state and substantially preventing transfer of the resonant optical signal while in the second operational state.

40. A resonant optical filter, comprising:

- a first transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of an optical WDM system, the first transmission optical waveguide having an evanescent optical coupling segment;
- a second transmission optical waveguide adapted for transmitting therethrough a plurality of optical signals, each of the optical signals being carried by a respective waveguide optical mode corresponding to an optical channel of the optical WDM system, the second transmission optical waveguide having an evanescent optical coupling segment;
- a resonant optical component including at least one fiber-ring optical resonator, the resonant optical component being evanescently optically coupled to each of the first transmission optical waveguide and the second transmission optical waveguide at the respective evanescent optical coupling segment thereof for transferring a resonant optical signal between the first transmission optical waveguide and the second transmission optical waveguide, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently

different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator, the resonant optical signal being substantially resonant with at least one of the resonant optical modes; and a modulator switchable between first and second operational states for controlling an optical resonance frequency of the resonant optical component, the modulator substantially enabling transfer of the resonant optical signal while in the first operational state and substantially preventing transfer of the resonant optical signal while in the second operational state.

41. A method for dividing a plurality of optical signals transmitted by an optical WDM system, comprising the steps of:
- receiving a plurality of optical signals, each carried by a corresponding optical WDM channel, through a first transmission optical waveguide, the first transmission optical waveguide being evanescently optically coupled to a resonant optical component;
 - permitting a non-resonant subset of the received optical signals to pass substantially undisturbed through the first transmission optical waveguide, each of the non-resonant subset of the received optical signals being substantially non-resonant with any resonant optical mode of the resonant optical component; and
 - routing a resonant subset of the received optical signals from the first transmission optical waveguide through the resonant optical component and into a second transmission optical waveguide, the second transmission optical waveguide being evanescently optically coupled to the resonant optical component, each of the resonant subset of the received optical signals being substantially resonant with at least one corresponding resonant optical mode of the resonant optical component, thereby dividing the non-resonant and resonant subsets of the received optical signals into the first and second transmission optical waveguides, respectively,
- the resonant optical component including at least one fiber-ring optical resonator, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second

segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator.

42. A method for combining a plurality of optical signals transmitted by an optical WDM system, comprising the steps of:
- a. receiving a non-resonant subset of a plurality of received optical signals, each carried by a corresponding optical WDM channel, through a first transmission optical waveguide, the first transmission optical waveguide being evanescently coupled to a resonant optical component;
 - b. receiving a resonant subset of the plurality of received optical signals, each carried by a corresponding optical WDM channel, through a second transmission optical waveguide, the second transmission optical waveguide being evanescently coupled to the resonant optical component;
 - c. permitting the non-resonant subset of the received optical signals to pass substantially undisturbed through the first transmission optical waveguide, each of the non-resonant subset of the received optical signals being substantially non-resonant with any resonant optical mode of the resonant optical component; and
 - d. routing the resonant subset of the received optical signals from the second transmission optical waveguide through the resonant optical component and into the first transmission optical waveguide, each of the resonant subset of the received optical signals being substantially resonant with at least one corresponding resonant optical mode of the resonant optical component, thereby combining the resonant and non-resonant subsets of the received optical signals into the first transmission optical waveguide,
- the resonant optical component including at least one fiber-ring optical resonator, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator.

43. A method for dropping an optical signal from a plurality of optical signals transmitted by an optical WDM system, comprising the steps of:

- a. receiving a plurality of optical signals, each carried by a corresponding optical WDM channel, through a first transmission optical waveguide, the first transmission optical waveguide being evanescently optically coupled to a resonant optical component;
- b. permitting a non-resonant subset of the received optical signals to pass substantially undisturbed through the first transmission optical waveguide, each of the non-resonant subset of the received optical signals being substantially non-resonant with any resonant optical mode of the resonant optical component; and
- c. routing a resonant one of the received optical signals from the first transmission optical waveguide through the resonant optical component and into a second transmission optical waveguide, the second transmission optical waveguide being evanescently optically coupled to the resonant optical component, the resonant one of the received optical signals being substantially resonant with at least one corresponding resonant optical mode of the resonant optical component, thereby dropping the resonant one of the received optical signals from the first transmission optical waveguide into the second transmission optical waveguide,

the resonant optical component including at least one fiber-ring optical resonator, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator.

44. A method for adding an optical signal to a plurality of optical signals transmitted by an optical WDM system, comprising the steps of:

- a. receiving a non-resonant subset of a plurality of received optical signals, each carried by a corresponding optical WDM channel, through a first transmission optical waveguide, the first transmission optical waveguide being evanescently coupled to a resonant optical component;

- b. receiving a resonant one of the plurality of received optical signals, carried by a corresponding optical WDM channel, through a second transmission optical waveguide, the second transmission optical waveguide being evanescently coupled to the resonant optical component;
- c. permitting the non-resonant subset of the received optical signals to pass substantially undisturbed through the first transmission optical waveguide, each of the non-resonant subset of the received optical signals being substantially non-resonant with any resonant optical mode of the resonant optical component; and
- d. routing the resonant one of the received optical signals from the second transmission optical waveguide through the resonant optical component and into the first transmission optical waveguide, the resonant one of the received optical signals being substantially resonant with at least one corresponding resonant optical mode of the resonant optical component, thereby adding the resonant one of the received optical signals to the non-resonant subset of the received optical signals in the first transmission optical waveguide,

the resonant optical component including at least one fiber-ring optical resonator, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator.

45. A method for dividing a plurality of optical signals, comprising the steps of:

- a. receiving a plurality of optical signals through a first transmission optical waveguide, the first transmission optical waveguide being evanescently optically coupled to a resonant optical component;
- b. permitting a non-resonant subset of the received optical signals to pass substantially undisturbed through the first transmission optical waveguide, each of the non-resonant subset of the received optical signals being substantially non-resonant with any resonant optical mode of the resonant optical component; and

- c. routing a resonant subset of the received optical signals from the first transmission optical waveguide through the resonant optical component and into a second transmission optical waveguide, the second transmission optical waveguide being evanescently optically coupled to the resonant optical component, each of the resonant subset of the received optical signals being substantially resonant with at least one corresponding resonant optical mode of the resonant optical component, thereby dividing the non-resonant and resonant subsets of the received optical signals into the first and second transmission optical waveguides, respectively,

the resonant optical component including at least one fiber-ring optical resonator, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator.

46. A method for dropping an optical signal from a plurality of optical signals, comprising the steps of:
- a. receiving a plurality of optical signals through a first transmission optical waveguide, the first transmission optical waveguide being evanescently optically coupled to a resonant optical component;
 - b. permitting a non-resonant subset of the received optical signals to pass substantially undisturbed through the first transmission optical waveguide, each of the non-resonant subset of the received optical signals being substantially non-resonant with any resonant optical mode of the resonant optical component; and
 - c. routing a resonant one of the received optical signals from the first transmission optical waveguide through the resonant optical component and into a second transmission optical waveguide, the second transmission optical waveguide being evanescently optically coupled to the resonant optical component, the resonant one of the received optical signals being substantially resonant with at least one corresponding resonant optical mode of the resonant optical component, thereby dropping the resonant one of

the received optical signals from the first transmission optical waveguide into the second transmission optical waveguide,

the resonant optical component including at least one fiber-ring optical resonator, each fiber-ring optical resonator including a transverse resonator segment integral with a resonator optical fiber between first and second segments of the resonator optical fiber and having a circumferential optical path length sufficiently different from a circumferential optical path length of an immediately adjacent portion of at least one of the first and second segments of the resonator optical fiber so as to enable the resonator segment to support at least one resonant optical mode near an outer circumferential surface of the fiber-ring optical resonator.

07/30/2001

REMARKS

Claims 15-46 have been newly added to the application and claim subject matter disclosed in the application as originally filed but not necessarily claimed therein.. Each of Claims 15-46 finds support in the drawings, written description, and/or claims of the application as originally filed.

Applicant awaits a first substantive Office Action on the application.

Respectfully submitted,



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07/30/2001